v_2 and NCQ-scaling in a hadronic transport model

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Yan Lu, F. Liu, Z. Liu, M. Bleicher, H. Stocker, P. Sorensen, N. Xu

(1) Introduction

- Can hadronic interactions reproduced some of the observed features?
- Why?

(2) RQMD model results

(3) Summary

Equation of State

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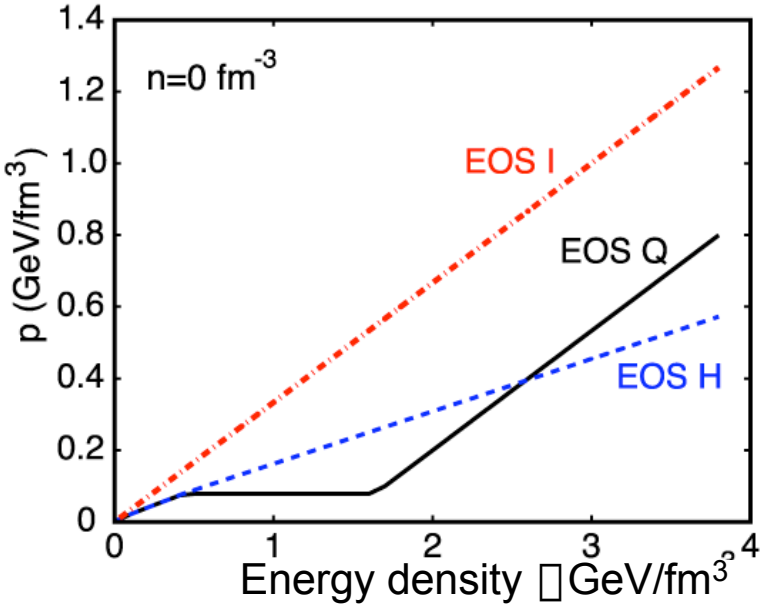
$$\partial_\mu T^{\mu\nu} = 0$$

$$\partial_\mu j^\mu = 0 \qquad j^\mu(x) = n(x)u^\mu(x)$$

$$T^{\mu\nu} = [\varepsilon(x) + p(x)]u^\mu u^\nu - g^{\mu\nu} p(x)$$



With given degrees of freedom, the EOS - the system response to the changes of the thermal condition - is fixed by its ***p*** and ***T*** or ε.

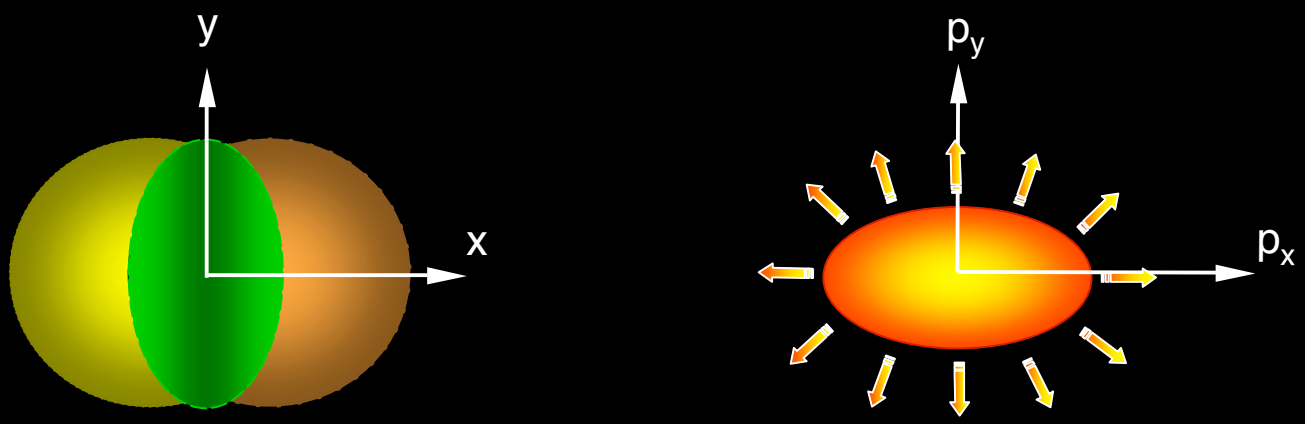
Equation of state:

- **EOS I** : relativistic ideal gas: $p = \varepsilon/3$
- **EOS H**: resonance gas: $p \sim \varepsilon/6$
- **EOS Q**: Maxwell construction:
  T_{crit}= 165 MeV, $B^{1/4}$ = 0.23 GeV
  ε_{lat}=1.15 GeV/fm^3

P. Kolb et al., Phys. Rev. ***C62****, 054909 (2000).*

Anisotropy parameter v_2

coordinate-space-anisotropy ⇒ momentum-space-anisotropy



$$\varepsilon = \frac{\langle y^2 \rangle - \langle x^2 \rangle}{\langle y^2 + x^2 \rangle} \qquad v_2 = \langle \cos 2\phi \rangle, \quad \phi = \tan^{-1}\left(\frac{p_y}{p_x}\right)$$

Initial/final conditions, EoS, degrees of freedom

Partonic collectivity at RHIC

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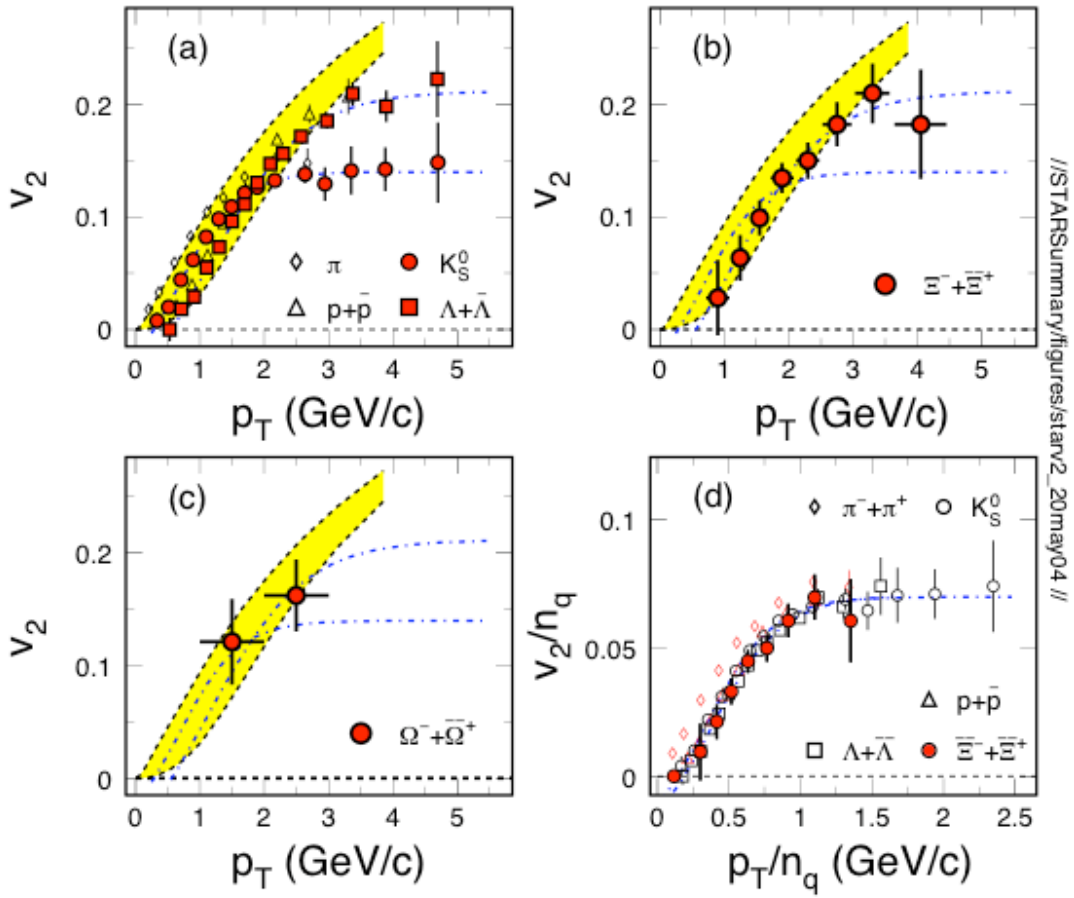

From v_2, hadron spectra, and the scaling properties:

➪ **Partonic collectivity has been attained at RHIC!**

➪ **Deconfinement, model dependently, has been attained at RHIC!**

Open charm v_2 - a comparison

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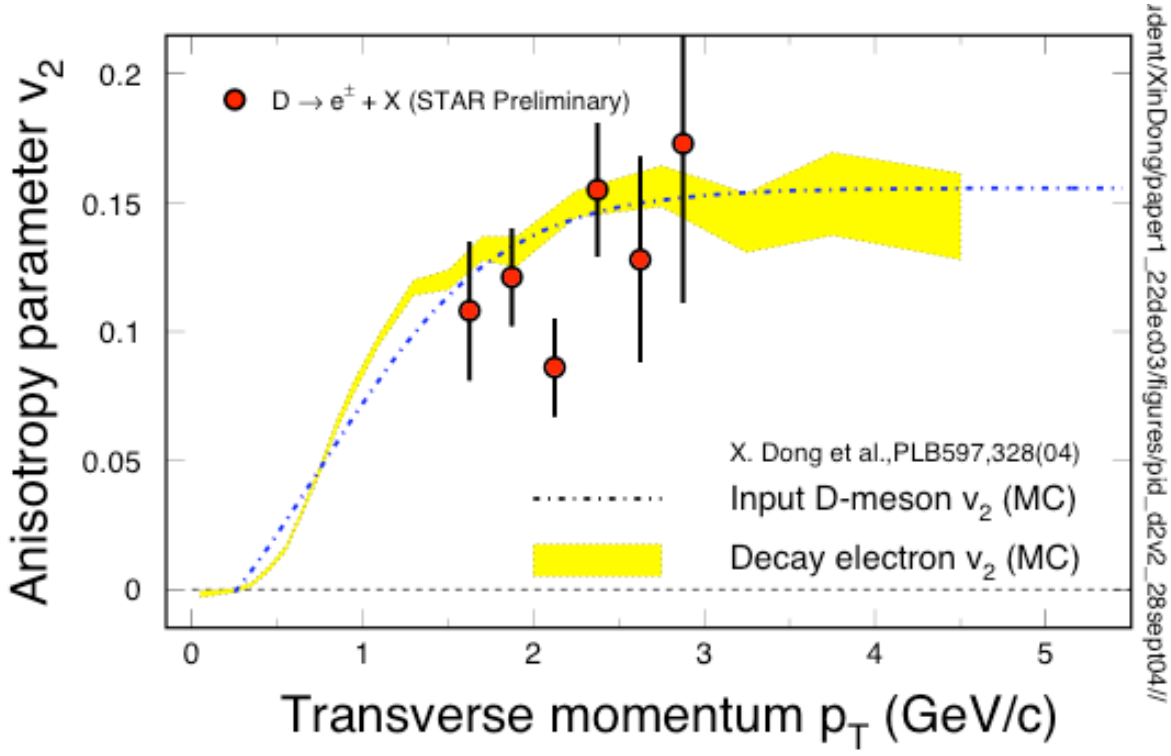
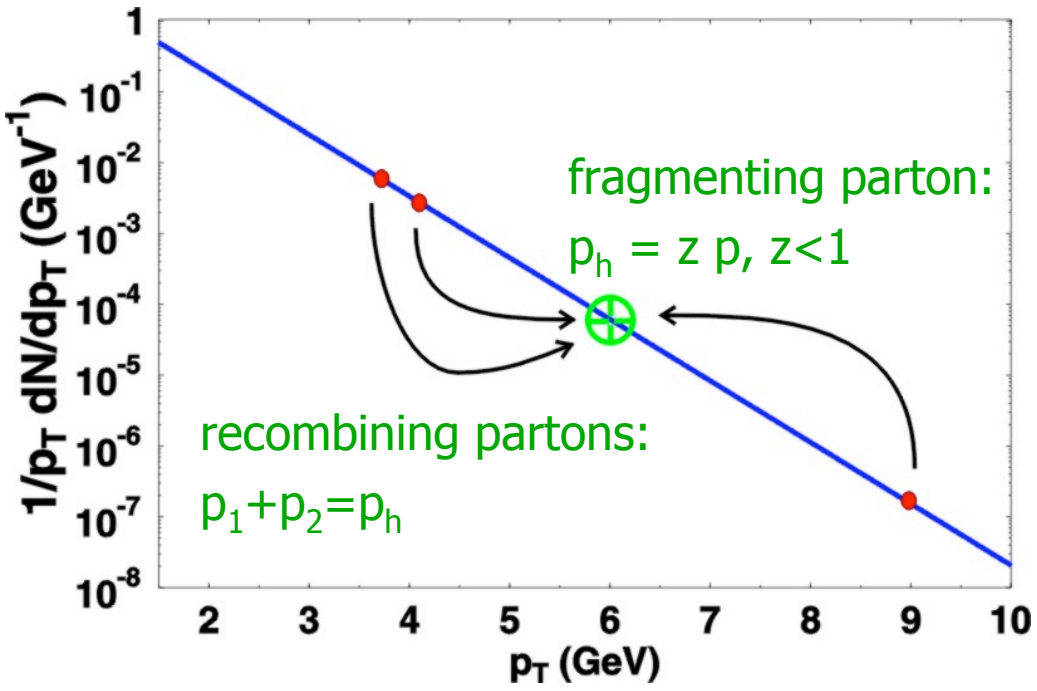


1) *Constituent Quark Scaling for open charm hadron production?*
2) *Flow of charm-quark and the thermalization among light flavors?*
3) *…????*

X. Dong, S. Esumi, P. Sorensen, N. Xu and Z. Xu, Phys. Lett. ***B597****, 328(2004).*

Quark Recombination



1) Recombination or coalescence is a natural process for converting partons to hadrons - hadronization. For an exponential parton spectrum, recombination is more effective than fragmentation

2) A baryons are shifted to higher p_T than mesons, for same quark distribution.

R. Fries nucl-th/04010085

Figure 1

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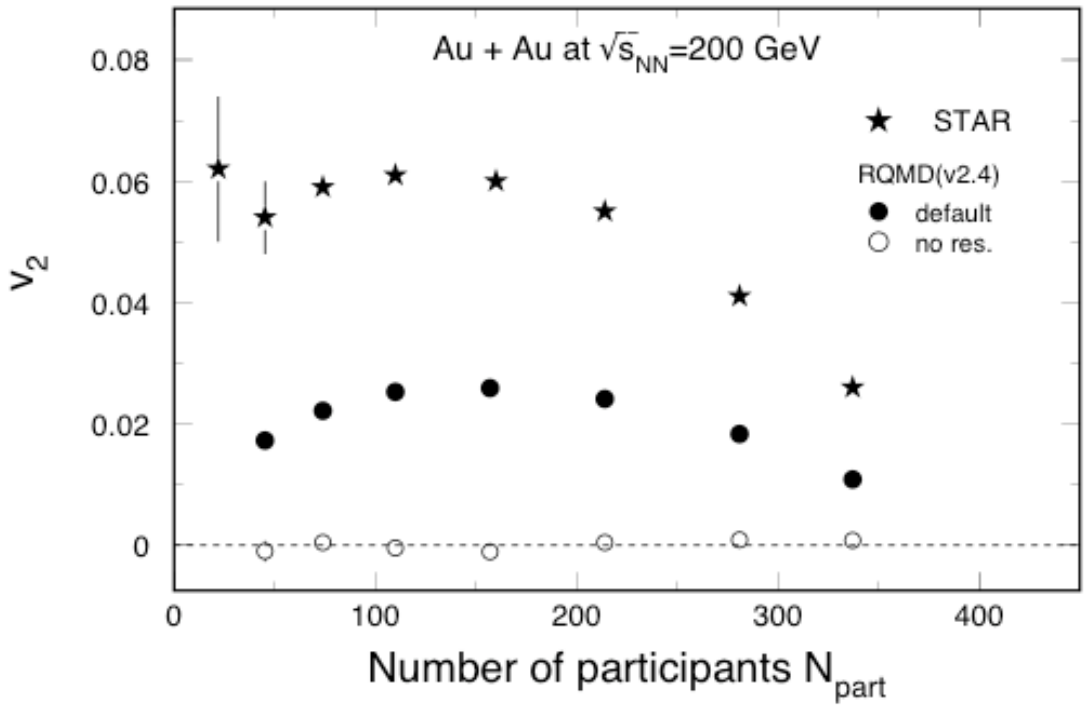
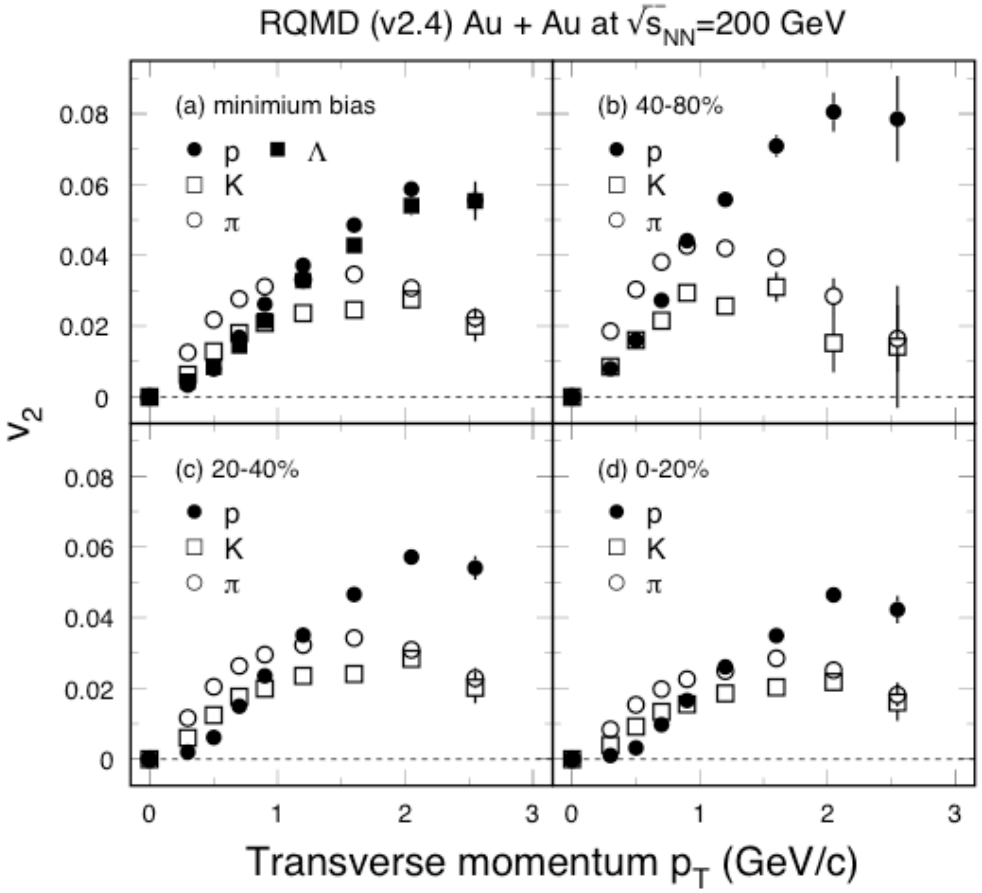


Calculations under-predict the absolute values of v_2 - lack of hot and dense partonic interactions in the model.

Figure 2



1) At low p_T region: mass ordering - feature of hydrodynamic motion

2) Hadron type dependence at the intermediate p_T region - vacuum hadronic cross sections used in the model

Figure 3

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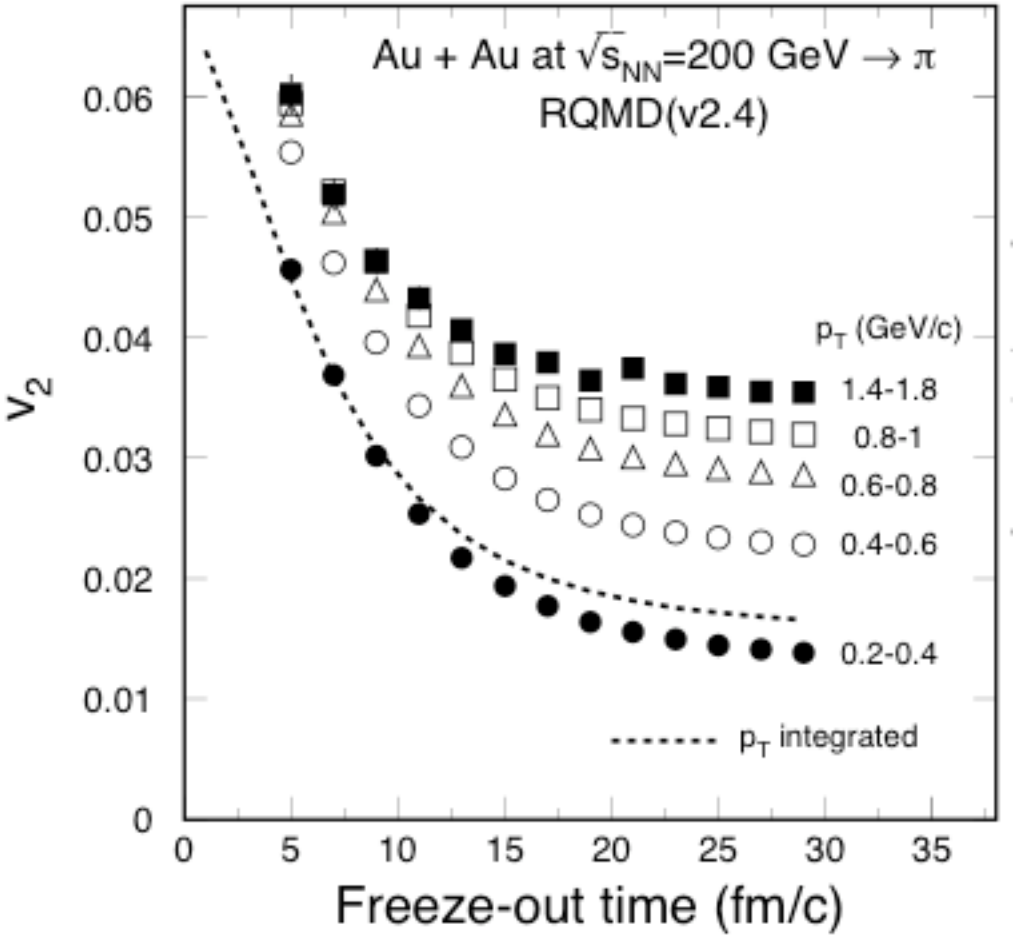
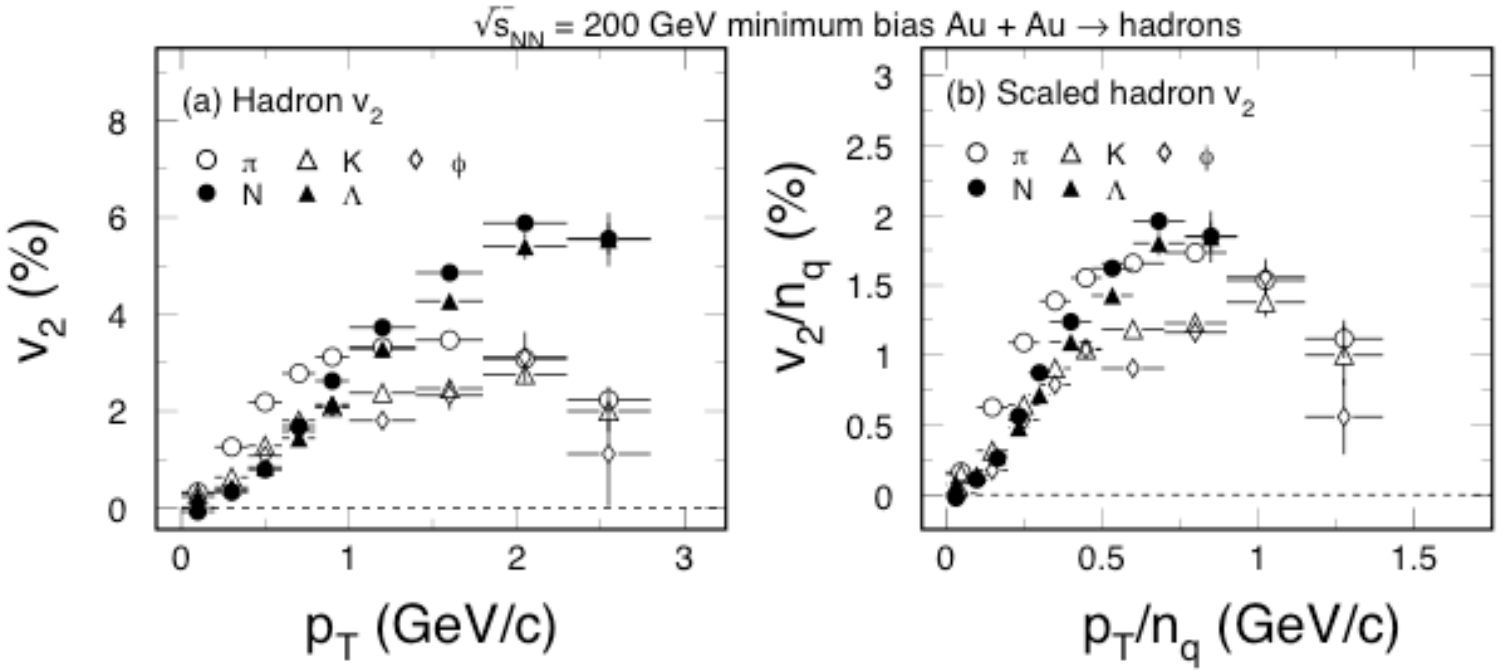


1) Higher p_T hadrons freeze-out with higher values of v_2

2) Earlier freeze-out hadrons have higher values of v_2. After 15 fm/c,not much changes in v_2.

Figure 4



1) At low p_T region: pions do not following the scaling - resonance decay effects

2) At p_T/N_q > 0.5 GeV/c, scaling seems to work except □-meson

Summary

1) RQMD under predicts absolute values of v_2, due to lack of hot and dense partonic interaction in the model.

2) Low p_T region: hadron mass dependence observed via rescatterings.

3) Intermediate p_T region: hadron type dependence observed, due to the vacuum hadronic cross sections used in the hadronic model **the NCQ-scaling explanation may not be unique!**

4) High precision data on v_2 of K*, , , *, * are important!